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LIQUID CRYSTAL DROPPING DEVICE AND LIQUID CRYSTAL DROPPING METHOD

[Abstract]

PROBLEM TO BE SOLVED: To suppress the dispersion of dropping quantity of a liquid crystal and to omit frequent supplements of the liquid crystal to a micro syringe, when the liquid crystal is dropped onto a substrate by using the micro syringe.

SOLUTION: A liquid crystal dropping device provided with a liquid crystal tank 4 and a switching valve 1 for switching passages is used. After a passage communicating from the liquid crystal tank 4 to a recovering vessel 5 through the switching valve 1 is formed and a passage 3a of the switching valve 1 is filled with the liquid crystal L, a passage communicating from the liquid crystal tank 4 to the micro syringe 6 through the switching valve 1 is formed and the liquid crystal L is taken in the micro syringe 6. Then a passage communicating from the micro

syringe 6 to a dropping nozzle 9 through the switching valve 1 is formed and a prescribed quantity of liquid crystal L is ejected from the micro syringe 6 by the precise feeding of a piston 7. Then a passage communicating from a pressurized gas source G to the dropping nozzle 9 through the switching valve 1 is formed and the pressurized gas is introduced to eject the all quantity of the liquid crystal L in the passage from the dropping nozzle 9.

[Claim(s)]

[Claim 1] A one-drop fill apparatus for liquid crystals comprising a liquid crystal tank for storage of liquid crylstals, a micro-syringe, and a piston accurate motion device to move a piston of the micro-syringe by only a predetermined amount, and a switching valve to change a flow path and a one-drop fill nozzle, wherein the flow path changed and formed by the switching valve includes a first flow path from the liquid crystal tank communicating with the micro-syringe via the switching valve; a second flow path from the micro-syringe communicating with the one-drop fill nozzle via the switching valve; and a third flow path from a compressed gas source communicating with the one-drop fill nozzle via the switching valve, of which the first flow path is for introducing the liquid crylstals into the micro-syringe, the second flow path is for ejecting the liquid crystals in a constant amount only from the micro-syringe by the piston accurate motion device and the third flow path is for ejecting the liquid crystals from the one-drop fill nozzle.

[Claim 2] The one-drop fill apparatus as set forth in claim 1, wherein the one-drop fill nozzle has a double-cylindrical structure comprising an inner duct and an outer duct at a front end of the nozzle, in which the outer duct communicates with the compressed gas source and the compressed gas blows into through the outer

duct while the liquid crystals are ejected out of the inner duct.

[Claim 3] A one-drop fill process for liquid crystals using the one-drop fill apparatus as set forth in claim 1 comprising the steps of: forming the first path from the liquid crystal tank communicating with the micro-syringe while interposing the switching valve and introducing the liquid crystals into the micro-syringe; forming the second path from the micro-syringe communicating with the one-drop fill nozzle via the switching valve and ejecting the liquid crystals from the micro-syringe in a constant amount only by the piston accurate motion device; and forming the third flow path from the compressed gas source communicating with the one-drop fill nozzle while interposing the switching valve and introducing the compressed gas into the third flow path, thus, ejecting the liquid crystals in the third flow path as a whole from the one-drop fill nozzle.

[Title of the Invention]

METHOD AND APPARATUS FOR ONE-DROP FILLING LIQUID CRYSTALS

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to preparation of liquid crystal panels, in

particular, an apparatus and a method for one-drop filling liquid crystal on a glass substrate in fabrication of large sized liquid crystal panels.

[Description of the Prior Art]

Among large size liquid crystal panels used in products having a display such as personal computer, TV and so on, there is most widely adopted an active-matrix type color liquid crystal panel by TFT way. Such liquid crystal panel has been manufactured facing two sheets of glass plate having electrodes formed with each other, adhering around fringes thereof by a sealant and vacuum-injecting liquid crystal into an aperture between the glass plates.

However, the above process required extremely long time for a large-size panel of introduction of liquid crystal (for example, one day for 20 inch panel), thus, recently adopts the following way: firstly, a sheet of glass plate is applied with a sealant around fringe thereof, followed by one-drop filling a constant amount of liquid crystal into image display region of the glass plate. Next, the glass plate contacts and is adhered to another sheet of glass plate in a vacuum condition, then, is heated in an atmosphere to cure the sealant.

It is necessary to priactically conduct the one-drop filling process of the liquid crystal in a wide range by dividing the liquid crystal into a number of drops, for example, more than several tens of drop such that the liquid crystal after adhering

both of the glass plate sheets rapidly and evenly spreads over the sheets. When the one-drop fill amounts to totally 500mg, one drop has several mgs of amount. A particular example of the apparatus and the method for one-drop filling liquid crystal comprises introducing the liquid crystal in a vertical micro-syringe, precisely moving a piston (or plunger) of the syringe to eject a very small amount of the liquid crystal from the one-drop nozzle, dropping the liquid crystal over a glass plate, and repeatedly carrying out the dropping step while moving any one of the glass plate or the micro-syringe.

[Problems to be solved by the Invention]

However, since the above known apparatus and method for dropping an extremely small amount, for example, about several mgs, of liquid crystal per a time, then suffer drawbacks in that they are easy to cause irregularity in amount of the liquid crystal one-drop fill at every time, thus, have a difficulty in satisfying a desired accuracy (for example, ± 1%) of total weight of the one-drop fill. Further, the liquid crystal should be often filled up in the micro-syringe,

Accordingly, the present invention has an object of solving the foregoing problems and provides an apparatus and a method for one-drop filling liquid crystal useful for removing irregularity in amount of the liquid crystal one-drop fill while eliminating a troublesome labor to frequently fill up the liquid crystal into the micro-

syringe.

[Means for Solving the Problem]

In a first aspect of the present invention to accomplish the objects described above, a liquid crystal one-drop fill apparatus comprises a liquid crystal tank for storing the liquid crystal, a micro-syringe, a piston accurate motion device to move a piston of the micro-syringe in a predetermined amount only, an one-drop fill nozzle and a switching valve to change a flow path; wherein the flow path includes a first flow path from the liquid crystal tank communicating with the micro-syringe via the switching valve; a second flow path from the micro-syringe communicating with the one-drop fill nozzle via the switching valve; and a third flow path from a compressed gas source communication with the one-drop fill nozzle via the switching valve in order, and is characterized in that the liquid crystal is introduced in the micro-syringe when the first flow path is formed, ejected in a constant amount only from the micro-syringe by the piston accurate motion device when the second flow path is formed, and ejected from the one-drop fill nozzle by introducing a compressed gas when the third flow path is formed.

In another aspect of the present invention, a liquid crystal one-drop fill process using a liquid crystal one-drop fill apparatus which includes a liquid crystal tank for storing the liquid crystal, a micro-syringe, a piston accurate motion device

to move a piston of the micro-syringe in a predetermined amount only, an one-drop fill nozzle and a switching valve to change a flow path comprises steps of: forming a first flow path from the liquid crystal tank communicating with the micro-syringe through the switching valve and introducing the liquid crystal into the micro-syringe; forming a second flow path from the micro-syringe communicating with the one-drop fill nozzle via the switching valve and ejecting the liquid crystal from the micro-syringe in a constant amount only by the piston accurate motion device; and forming a third flow path from a compressed gas source communicating with the one-drop fill nozzle while interposing the switching valve and introducing the compressed gas into the third flow path, thus, ejecting the liquid crystal in the third flow path as a whole from the one-drop fill nozzle.

Briefly, since the switching valve changes the flow path after filling up the liquid crystal in the flow path involving the switching valve, the flow path charged with the liquid crystal is blocked by the switching valve to define amount of the liquid crystal. The defined liquid crystal as a whole is pushed out of the one-drop fill nozzle by the compressed gas, thereby not causing irregularity in amount of the liquid crystal one-drop fill at every time. In addition, the present method includes the step of introducing the liquid crystal from the liquid crystal tank into the micro-syringe within one cycle of changing the flow path, thereby requiring no supplement of further liquid crystal by a worker oneself.

[Embodiment of the Invention]

Hereinafter, the present invention will become apparent from the following detailed description, considered in conjunction with the accompanying drawings.

Referring to the drawings, the first embodiment of the present invention is shown in FIG. 1 and FIG. 2. FIG. 1 illustrates a construction of the apparatus according to the first embodiment of the present invention. In FIG. 1, illustrated are a switching valve 1, a main body 2 of the switching valve 1, another main body 3 of the switching valve 1, a liquid crystal tank 4 for storing the liquid crystal L, a recovery container 5 of the liquid crystal L, a micro-syringe 6, a piston (or plunger) 7 of the micro-syringer 7, a piston accurate motion device 8 and an one-drop fill nozzle 9.

The switching valve 1 is 5 ports 4 positions type and comprises the main body 2 having five(5) ports 2a to 2e and the other main body 3 having a pathway 3a consisting of microfine penetration holes. The main body 3 changes the flow path four times by one(1) revolution thereof. Since the five ports 2a to 2e are disposed by an equal pitch (for example, at a central angle of 60 degree for each of the ports in this case), then, a distance between both ends of the pathway 3a is exactly same to one pitch of the port. The port 2a connects with a recovery duct 5a leading to the recovery container 5 and the port 2b connects with a liquid feeding duct 4a from the

liquid crystal tank 4. The port 2c connects with the micro-syringe 6 and the port 2d connects with an ejection duct 9a leading to the one-drop fill nozzle 9. Further, the port 2e connects with a gas feeding duct 9b communicating to a compressed gas source G. The liquid crystal tank 4 connects with another gas feeding duct 4b communicating to the compressed gas source G.

The micro-syringe 6 has the piston 7 sliding into a micro tube (for example, having an inner diameter of 1mm or less). The piston accurate motion device 8 consists of, for example, pulse motor and ball type screw to enable the piston 7 accurately moving in the predetermined amount only. The one-drop fill nozzle 9 is preferably made of Teflone (registered tradename) on front end thereof because the material easily bounds the liquid crystal.

FIGs. 2(A) to 2(D) illustrate the flow path of the first embodiment according to the present invention. For the parts in FIGs. 2(A) to 2(D) identical to the parts shown in FIG. 1, the same numerical symbols are given. First of all, if the pathway 3a of the switching valve 1 is on the first position from the port 2a to the port 2b (see FIG. 2(A)), the pathway 3a is filled with the liquid crystal L by introducing a compressed gas (that is, inert gas such as nitrogen) to the liquid tank 4. When the pathway 3a is on the second position from the port 2b to the port 2c (see FIG. 2(B)), a constant amount of the liquid crystal L is inhaled into the micro-syringe 6 by

moving the piston 7 in the predetermined amount only with the piston accurate motion device 8.

Next, in the third position from the port 2c to the port 2d (see FIG. 2(C)), the piston is pushed back by the piston accurate motion device 8. As a result, the liquid crystal L is ejected in the constant amount only from the pathway 3a and entered into the ejection duct 9a. Subsequently, in the fourth position from the port 2d to the port 2e (see FIG. 2(D)), by introducing the compressed gas (that is, inert gas such as nitrogen) to the switching valve 1, the liquid crystal L in both of the pathway 3a and the ejection duct 9a is entirely ejected out from the the one-drop fill nozzle. Thereafter, the process returns to the first postion and repeats all of the steps described above. The liquid crystal is dropped at 3 to 7mg per drop and widely by dividing and one-drop filling more than several tens of drop at equal spaces.

The second embodiment of the present invention is shown in FIG. 3. FIG. 3(A) and FIG. 3(B) illustrate the flow path of the second embodiment according to the present invention. For the parts in FIG. 3(A) and 3(B) identical to the parts shown in FIG. 1 and FIG. 2, the same numerical symbols are given. The switching valve 11 is 4 ports 2 positions type and comprises a main body having four(4) ports 12a to 12d and the other main body having two pathways 13a and 13b consisting of microfine penetration holes. The main body changes the flow path twice by

pivotal rotation thereof (at a rotational angle of 90 degree for the main body in this case).

Since the four ports 2a to 2e are disposed by an equal pitch (at a central angle of 90 degree for each of the ports in this case), then, a distance between both ends of the pathways 3a and 3b is exactly same to one pitch of the port. The port 12a connects with the liquid feeding duct 4a from the liquid crystal tank 4. The port 12b connects with the micro-syringe 6 and the port 12c connects with the ejection duct 9a leading to the one-drop fill nozzle 9. Further, the port 12d connects with the gas feeding duct 9b communicating to the compressed gas source G.

First of all, if the flow path containing the pathway 13a of the switching valve 11 is on the first position that the pathway 13a passes from the port 12a to the port 12b while the pathway 13b passing from the port 12c to the port 12d (see FIG. 3(A)), a constant amount of the liquid crystal is inhaled into the micro-syringe 6 by pulling the piston 7 in the predetermined amount only with the piston accurate motion device 8 while interposing the pathway 13a filled with the liquid crystal. Besides, the flow path containing the pathway 13b introduces the compressed gas (that is, inert gas such as nitrogen) from the port 12d into the pathway 13b and the liquid crystal L charged in the ejection duct 9a is entirely ejected out from the the one-drop fill nozzle 9.

Next, if the flow path containing the pathway 13a of the switching valve 11 is on the second position that the pathway 13a passes from the port 12b to the port 12c while the pathway 13b passing from the port 12a to the port 12d (see FIG. 3(B)), a constant amount of the liquid crystal is pushed out of the pathway 13a into the ejection duct 9a by pushing back the piston 7 in the predetermined amount only with the piston accurate motion device 8. Besides, the flow path containing the pathway 13b still comes to rest. Thereafter, the process returns to the first postion and repeats all of the steps described above.

Yet the third embodiment of the present invention is described in detail referring to FIG. 4. FIG. 4 is a sectional view of inner duct section of the apparatus in the third embodiment of the present invention. For the parts in FIG. 4 identical to the parts shown in FIG. 1 and FIG. 2, the same numerical symbols are given. Herein, the apparatus has an one-drop fill nozzle 19 with a double-cylindrical structure consisting of an inner duct 19a and an outer duct 19b instead of the one-drop fill nozzle 9 in the second embodiment and communicates with the compressed gas source while interposing the inner duct 19a and a gas feeding duct 19c during the connection of the ejection duct 9a with the front end of the nozzle 19. The compressed gas (that is, inert gas such as nitrogen) is introduced and blows into through the outer duct in a direction parallel to the ejection of liquid crystal while ejecting the liquid crystal out of the inner duct 19a.

Accordingly, the liquid crystal does not adhere on front end of the one-drop fill nozzle even when the front end is made of a material hardly bounding the liquid crystal, thereby causing no irregularity in amount of the liquid crystal one-drop fill due to adhesion of the liquid crystal.

The above embodiments are only used to illustrate the present invention, not intended to limit the scope thereof. Those skilled in the art will readily appreciate that numerous modifications and alterations of the invention may be made without departing from the scope of the present invention.

[Effect of the Invention]

As described above, the present invention provides the liquid crystal one-drop fill method and apparatus which have no irregularity in amount of the liquid crystal one-drop fill at every time and can eliminate a troublesome labor to frequently fill up the liquid crystal into the micro-syringe.

[Description of Drawings]

FIG. 1 illustrates a construction of the apparatus according to the first embodiment of the present invention.

FIGs. 2A to 2B illustrate the flow path of the first embodiment according to the present invention.

FIG. 3A and FIG. 3B illustrate the flow path of the second embodiment according to the present invention.

FIG. 4 is a sectional view of inner duct section of the apparatus in the third embodiment of the present invention

[Meaning of numerical symbols in the drawings]

1:	switching valve	2:	valve main body
2a, 2b, 2c, 2d, 2e:	port	3:	valve main body
3a:	pathway	4:	liquid crystal tank
4a:	liquid feeding duct	4b:	gas feeding duct
5:	recovery container	5a:	recovery duct
6:	micro-syringe	7:	piston
8:	piston accurate motion device	9:	one-drop fill nozzle

9a: ejection duct

9b: gas feeding duct

11: switching valve

12a, 12b, 12c, 12d: port

13a, 13b: pathway

19: one-drop fill nozzle

19a: inner duct

19b: outer duct

19c: gas feeding duct